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EXPLORATORY TUNA FISHING IN INDONESIAN WATERS

SPECIAL SCIENTIFIC REPORT: FISHERIES No. 45

UNITED STATES DEPARTMENT OF THE INTERIOR
FISH AND WILDLIFE SERVICE

EXPLANATORY NOTE

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Washington, D. C.
January 1951

United States Department of the Interior
Oscar L. Chapman, Secretary
Fish and Wildlife Service
Albert M. Day, Director

Special Scientific Report - Fisheries
No. 45

EXPLORATORY TUNA FISHING IN INDONESIAN WATERS

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Pacific Oceanic Fishery Investigations

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1/ South Sea Fishery News [Nanyō Suisan Jōhō], Vol. 5, No. 3, pp. 13-17. June 25, 1941.

2/ South Sea Fisheries [Nanyō Suisan], No. 80, (Vol. 8), No. 1. January 25, 1942. pp. 29-41.

A Survey of Tuna Grounds in Equatorial Waters

1. Purpose.

Good results were obtained from the previous survey of tuna fishing grounds in the waters south of Palau, however, further attention must be paid to the equatorial waters, which are considered as a continuation of these fishing grounds, since they have been fished recently by tuna fishing vessels from Japan and since they must be considered as future fishing grounds. For this reason, an extensive area was surveyed to determine whether or not it has any value as a fishing ground. The findings are submitted herein as reference data for the planning of commercial operations. (Note) The first fishing test was planned in accordance with the northward shift of the Equatorial Counter-current at this season.

2. Particulars of the survey.

a. Survey period-May 9 to May 24, 1941-16 days

b. Area surveyed-From 6° N latitude to 1° S latitude and from 129° to 134o E longitude.

c. Survey ship. Zuihō Maru, 183 tons, 360 HP

d. Fishing gear used in the survey-Tuna longlines (50 baskets, 6 hooks per basket).

Brief description of one basket of tuna longline fishing gear. Main line - cotton line 10-strand, 45 gr per [5-foot] fathom; total length 175 fathoms (length of one section is 25 fathoms).
Branch lines-10-strand cotton line, 37.5 gr per fathom, length 12.5 fathoms. 6 pieces
Float lines-10-strand cotton line, 45 gr per fathom, length 12.5 fathoms. 1 piece
Cotton-covered wire-3 strands of 3 wires each, (eyes [?] both ends); length 4 fathoms, 6 pieces
Wire leader-length 1.5 fathoms, 6 pieces

3. Results.

(1) Result of each operation.

First fishing test, May 10

This fishing ground is located about 100 miles south of Palau (5°40'N, 134°31'E) and due to the seasonal northward shift of the Equatorial Counter-current, is believed to be in the Counter-current area. Details of the current, however, were not known.

Lines were set in a southwesterly direction from 50 baskets. Since the catch amounted to only 3 yellowfin and 1 big-eyed tuna, it was believed to be too early for the fishing season.

Second fishing test, May 12

This fishing ground is located about 300 miles south of the first fishing ground at 0°35' N latitude and 134°26' E longitude near the Equator. Lines from 50 baskets were set in a southerly direction. The current flowed W½N at 1.6 knots. The water temperatures of 29.6 degrees at the surface, 28.6 degrees at the 50-meter layer and 24.8 degrees at the 100-meter layer were satisfactory.

Since we were close to the Mapia Islands, young tunas were seen. The catch consisted of 25 yellowfin (5 shark-eaten) and 1 spearfish.

Third fishing test, May 13

This fishing ground is located near the Equator at 0°35' N latitude and 134°26' E longitude. Of the fishing grounds surveyed, this ground showed the best results (catch ratio of 14.0). [i.e. 14.0 fish per 100 hooks fished]. Lines from 50 baskets were set in a southerly direction. The current flowing W / N 3/4 N at 1.5 knots was roughly the same as that of the second fishing station and clearly indicated that this ground lies within the Southern Equatorial Current. The water temperatures were 30.5 degrees at the surface, 28.5 degrees at the 50-meter layer and 25.0 degrees at the 100-meter layer. The catch consisted of 37 yellowfin (5 shark-eaten) and 1 skipjack. The fish in general were small in size.

Fourth fishing test, May 14

This ground is located at 0°11' N latitude and 131°44' E longitude in the equatorial waters west of the third fishing ground. Lines from 50 baskets were set in a southeasterly direction. The current velocity was W / N at 1.3 knots (in the Southern Equatorial current). The water temperatures were 29.7 degrees at the surface, 26.5 degrees at the 50-meter layer, and 24.8 degrees at the 100-meter layer. The catch consisted of 25 yellowfin and 2 sailfish.

Fifth fishing test, May 15

This fishing ground is located about 1 degree north of the Equator at 1°11' N latitude and 131° 50' E longitude. Lines from 50 baskets were set in a westerly direction. The current flow was NW at 2.0 knots. The water temperatures were 29.8 degrees at the surface, 26.7 degrees at the 50-meter layer, and 24.8 degrees at the 100-meter layer. About one-half of the yellowfin catch consisted of young tuna (15 large yellowfin and 12 young yellowfin) which weighed from 2 to 3 kan [1 kan = 8.27 lbs.]. From two or three floating logs seen in the area this school is believed to have been associated with birds and driftwood.

Sixth fishing test, May 17

For the first time we entered the southern latitudes. This ground is located 14' south of the Equator at 0°14' S latitude and 129°25' E longitude. Lines from 50 baskets were set out to the NNW. This ground is located between the northwest shores of New Guinea and Halmahera Island. Numerous islands are found in the area and the flow of tidal currents is very complex. Numerous sharks infest the area and about one-half of the catch was shark-bitten. (The catch comprised 14 yellowfin, 13 of them shark-bitten, and 7 sharks.) The fish were generally large. The water temperatures were 29.5 degrees at the surface, 28.8 degrees at the 50-meter layer, and 23.0 degrees at the 100-meter layer.

Seventh fishing test, May 18

This fishing ground is located about 30 miles south of the sixth ground at 0°44.5' S latitude and 129°8.5' E longitude. Since the fish hold was full, only 30 baskets were used. Lines were set in a southerly direction. The flow of the current was similar to that of the sixth fishing ground. The catch consisted of 5 yellowfin and 1 sailfish.

(2) Investigation of the vertical distribution of the tuna (yellowfin) (Note) Float lines 12.5 fathoms long and branch lines 12.5 fathoms long (also cotton-covered wire 4 fathoms long and wire leaders 1.5 fathoms long) were used

(3) Handling of the catch.

After capture, the viscera were removed and the fish were washed. The washed fish were immediately wrapped in paper, covered with crushed ice, and stored in a refrigerator. Due to mechanical trouble, the refrigerator could not be operated during this trip. Although sufficient care was taken in icing, the fish deteriorated to a certain extent due to the length of time which elapsed before returning to Palau.

(4) The peculiar phenomena of the catch ratio and water temperature (at the 100-meter layer)

The catch ratios ranged from a minimum of 1.0 to a maximum of 14.0.

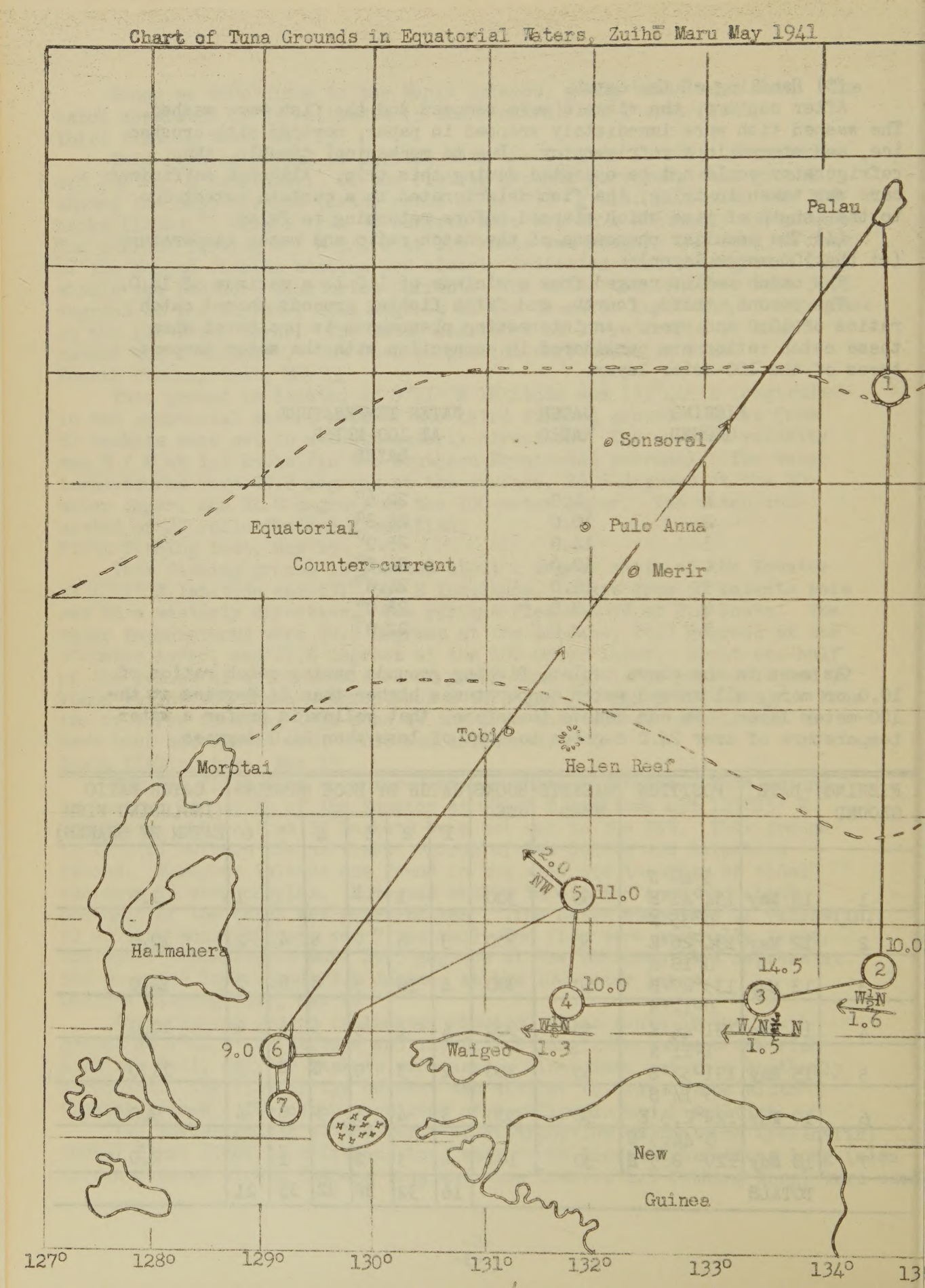
The second, third, fourth, and fifth fishing grounds showed catch ratios of 10.0 and over. An interesting phenomenon is presented when these catch ratios are considered in connection with the water temperatures of the 100-meter layer.

FISHING GROUND	CATCH RATIO	WATER TEMPERATURE AT 100-METER LAYER
1	1.0	22.6°
2	10.0	24.8°
3	14.0	25.0°
4	10.0	24.8°
5	11.0	24.8°
6	9.0	23.0°
7	2.0	22.0°

As seen in the above tables, fishing grounds having catch ratios of 10.0 or more, all showed water temperatures higher than 24 degrees at the 100-meter layer. We can deduce therefore, that yellowfin prefer a water temperature of over 24.0 degrees to that of less than 24.0 degrees.

FISHING GROUND	DATE	POSITION	BASKETS USED	HOOKS USED	CATCH BY HOOK NUMBERS						CATCH RATIO (INCLUDING FISH EATEN BY SHARKS)
					1	2	3	4	5	6	
1	10 May	5°40'N 134°41'E	50	300		1	1			1	1.0
2	12 May	0°35'N 134°26'E	50	300	3	6	7	8	4	2	10.0
3	13 May	0°18'N 133°27'E	50	300	4	10	9	8	8	3	14.0
4	14 May	0°12'N 131°44'E	50	300	4	4	5	5	6	6	10.0
5	15 May	1°11'N 131°50'E	50	300	2	3	9	8	8	5	11.0
6	17 May	0°14'S 129°2.5'E	50	300	3	4	5	3	8	4	9.0
7	18 May	0°44.5'S 129° 8.5'E	30	180		3	2		1		2.0
TOTALS					16	32	38	32	35	21	

Chart of Tuna Grounds in Equatorial Waters, Zuihō Maru May 1941



Report of Tuna Investigations by the Wakayama Prefecture Research Vessel, Kiyō Maru, in the Timor, Arafura, and Banda Seas

1. Introduction

With the recent grant of subsidy funds from the Colonial Office to the Nankō Fishing Company for the purpose of investigating the fisheries of the Outer South Seas area, the Company employed the Wakayama Prefecture research vessel, Kiyō Maru, to carry out a survey in the Timor, Arafura, and Banda seas, areas which are under foreign domination. I was aboard the vessel during that investigation and will publish herewith the information which was contained in the report submitted to the Colonial Office.

2. Outline of the Investigation

Period of the survey - From June 29, 1941, to July 25, 1941 - 27 days
Area surveyed - Timor Sea, Arafura Sea, Banda Sea
Surveying vessel - Kiyō Maru, research vessel of Wakayama Prefecture, a steel vessel of 127.23 gross tons and 220 horsepower.
Personnel of the survey - Technician Saburō Kawabe; the captain of the Kiyō Maru and 24 men
Fishing gear used in the survey - tuna longlines, 230 baskets
Construction of one basket of gear - trunk line of cotton, 8 momme to the fathom, [1 momme = .132 oz.] 189 fathoms overall length (7 pieces joined, each piece 29 fathoms long).
Branch lines of cotton, 9 momme to the fathom, 2 lines 10 fathoms long, 2 lines 7 fathoms long, 2 lines 6 fathoms long. Sekiyama of 3x3 strands of wire with eyes in both ends, 4 fathoms long.
Wire leader, 2 fathoms long.
Hooks, 4.86 inches and 3.2 inches long.
Float lines, cotton, 8 momme to the fathom, 15 fathoms long.
However, about half of the float lines and trunk lines were made of Manila hemp. [TN: The "fathoms" mentioned above are Japanese fathoms, about 5 feet long. Hook sizes are the total length from eye to point around the curve of the hook. The

sekiyama is a section of stiff served line between the leader and the branch line.]

Personnel Aboard the Kiyō Maru

Wakayama Prefecture Agricultural Technician	Kawabe, Saburō
South Seas Government-General Fisheries Experiment Station Technician	Ikebe, Kenzō
Head of Fishing Department, Nankō Fishing Company	Kobayashi, Itaru
Also of the Nankō Fishing Company	Sakurai, Daikichi
Captain	Tsuchii, Tatsuhiko
Chief Engineer	Iwamoto, Sōemon
Radioman	Kasajima, Shūji
Fishing Captain	Yagura, Otomatsu
Deckhand-Fisherman	Shima, Hidetarō
"	Higashi, Sadahachi
"	Ōtani, Fusao
"	Hatashimo, Kōichirō
"	Hamamoto, Iwazō
"	Ido, Masao
"	Okachi, Shōichirō
"	Kawachi, Hikotaro
"	Tanimoto, Tadao
"	Izumi, Kiichi
"	Nakamura, Jūichirō
"	Shiochi, Manpei
Oiler	Hatashimo, Sadami
"	Matsubara, Ekiichi
"	Kawabata, Hisao
"	Ibuki, Yoshio
"	Matsushita, Suzuo
"	Matsubara, Sadaichi

3. Progress of the Investigations

(1) Movements and sailing track

June 29 - 0900 - Departed Palau.
June 30 - noon - Passed west of Merir I.
July 1 - 0600 - Passed Tokoba I. to starboard.
July 2 - 1100 - Passed through Djailolo Passage.
July 4 - 0200 - Passed through Manibar Strait.
July 5 - Fished first station off Wotar I., set 50 baskets. (4 yellowfin, 1 black marlin, 1 broadbill, 2 skipjack)
July 6 - 0800 - Entered Dilli Harbor, Timor.
July 7 - At anchor at Dilli.
July 8 - 0900 - Departed Dilli.
July 9 - Fished second station off south side of Timor, set 200 baskets.
July 10 - 0200 - Finished operation. (18 yellowfin, 10 albacore, 3 big-eyed, 1 white marlin, 2 black marlin, 16 shark, 13 shark-eaten fish)

July 11 - Fished third station off south side of Babar I., set 120 baskets. (14 yellowfin, 2 big-eyed, 1 albacore, 1 broadbill, 47 fish bitten by sharks and killer whales).

July 12 - Fished fourth station west of Tanimbar I., set 120 baskets. (80 yellowfin, 1 true marlin, 1 sailfish, 1 big-eyed, 18 fish shark-bitten, 4 sharks)

July 13 - Fished fifth station at same position, set 185 baskets. (52 yellowfin, 1 big-eyed, 1 black marlin, 1 true marlin, 5 sharks, 10 fish shark-bitten)

July 15 - Fished sixth station west of Kei I., set 100 baskets. (78 yellowfin, 2 big-eyed, 6 sharks, 16 shark-bitten fish)

July 16 - Fished seventh station at same position, set 100 baskets. (47 yellowfin, 3 big-eyed, 2 white marlin, 8 fish shark-bitten)

July 17 - Fished eighth station east of Banda I., set 120 baskets. (42 yellowfin, 11 big-eyed, 9 sharks, 21 fish shark-bitten)

July 18 - Fished ninth station at same position, set 130 baskets. (116 yellowfin, 6 big-eyed, 17 sharks, 33 fish shark-bitten)

July 19 - Fished tenth station east of Ceram I., set 20 baskets. (4 yellowfin, 2 sharks, 2 fish shark-bitten)

July 20 - 1700 - Passed western end of Missol I.

July 21 - Noon - Passed through Sagewin Strait.

July 22 - Noon position 1° 51'N, 132° 10' E.

July 23 - Noon position 4° 17'N, 133° 28'E.

July 24 - 1000 - Passed east of Angaur I.

July 24 - 1530 - Entered Palau Harbor.

(2) Weather and sea conditions

The weather and sea conditions will be outlined for the areas in the order in which the research vessel passed through them after its departure from Palau on June 29.

After leaving Palau the vessel followed a generally southwest course. Until Angaur was passed at noon on the 29th the wind was northeast with forces of around 2 to 3 and the sea was calm, but on the following day, the 30th, the wind shifted to southwest and from 1100, when the vessel passed the vicinity of Merir I., to its entrance into Djailolo Passage on July 2 the wind force was from 5 to 7 and the waves were high. Because of the headwind the vessel took the seas on its bow and pitched violently. In the vicinity of Merir I., that is at 4° 18'N, 132° 17'E, the direction of the current was SSE with a velocity of 1.3 knots. Somewhat farther south at 3° 48'N, 132° 2'E the current was ESE with a velocity of 3.2 knots. At 3° 42'N, 131° 57'E the current was ESE with a high velocity of 3.0 knots. Still farther south at 2° 55'N, 131° 14'E, that is in the vicinity of Tokobe I., the current was SE with a velocity of 1.8 knots. From the directions of these currents it is clear that this sea area is bathed by the Equatorial Countercurrent. After passing Tokobe I., however, there was an area in which during this period almost no current drift was

perceived while steaming. It is not hard to deduce that this area corresponds to the boundary between the Equatorial Countercurrent and the southern Equatorial Current. Farther south at the northern end of Djailolo Passage, 1° 12'N, 129° 36'E, the current was NxW with a velocity of 0.5 knots. This area appears to be where the tip of the southern Equatorial Current which flows west along northern New Guinea strikes the islands of Halmahera and Morotai and turns northward.

After we passed through Djailolo Passage on July 3 the wind shifted to the south, but its force did not decrease, remaining at 5 to 6, and the seas were rather high. Thereafter until we passed Ceram I. the wind frequently shifted to southwest or south, but after we passed Ceram and entered the Banda Sea until we arrived at Timor the wind blew steadily from the southeast with forces of 4 to 5. This was the so-called easterly monsoon of the Banda Sea, a seasonal wind which continues until August. It is said that the strength of this wind gradually declines in September and October.

The color of the sea water everywhere between Tobalai I. and the west side of Ceram was notably poor as compared with that of the waters of the South Sea Islands. Even beyond Ceram in the Banda Sea the water color appeared generally to be unfavorable, however, farther south near Timor where the first station was fished off Wetar I. the water color seemed rather good. Observations made during the first fishing trial showed a transparency of 40 meters.

The vertical changes in water temperature at that position were 27.9° at the surface, 27.4° at 25 meters, 27.3° at 50 meters, 23.4° at 100 meters, 14.3° at 200 meters, 12.1° at 300 meters.

On July 8 the vessel sailed from Dilli on Timor I., proceeded east around the north coast, rounded the eastern tip of the island, and headed into the Timor Sea. At this time the wind was from the northeast and the force remained unchanged at 4 to 5. The air temperature at noon was as low as 26.5° and as a result we felt quite cold.

While anchored at Dilli we made inquiries concerning the weather there and found that generally May, June, July, and August are the dry season while January and February are the rainy season, the two seasons thus being just opposite to those of the Inner South Seas. During the so-called northeast monsoon, which is the dry season, dry cool winds blow, and although it is in the tropics one feels cool and refreshed. During the day in the Dilli region the seasonal wind begins to blow around 10:00 a.m. and ceases around 3:00 p.m., the morning and evening being usually completely windless. During the rainy season the wind blows from the northwest.

Observations taken at the second fishing station in the Timor Sea showed a transparency of 27 meters. The sea water seemed somewhat turbid compared to the previous station, and the vertical changes in water temperature were 27.3° at the surface, 26.8° at 25 meters, 26.7° at 50 meters, 23.4° at 100 meters, 13.2° at 200 meters, and 10.2° at 300 meters.

The position of the third station was southwest of Tanimbar I. in the western part of the Arafura Sea. The current at this position flowed southwest and a low velocity of 0.33 knot was detected. It is thought that the current which flows west in the northern part of the Arafura Sea strikes Tanimbar I. and turns southwest. The transparency was 17 meters and the vertical changes in water temperature were 26.2° at the surface, 26.1° at 25 meters, 25.0° at 50 meters, 19.8° at 100 meters, 14.8° at 200 meters, and 13.9° at 300 meters. The temperature at the 100-meter level was lower than that in the Timor Sea. This was the only ground we fished in the Arafura Sea. Thereafter we moved north into the Banda Sea and ran fishing stations at six places around the islands in the eastern part of that body of water. During these operations in the Banda Sea we constantly encountered the southeast monsoon. To be more exact, the wind was from the ESE and it blew steadily with forces generally from 3 to 5. The air temperature was around 85 or 86 degrees, and those of us who were accustomed to the heat of the Inner South Seas could feel the coolness soaking into our bodies. To summarize the results of the oceanographic observations made in the eastern part of the Banda Sea, the transparencies ranged from a maximum of 37 meters to a minimum of 22 meters, and the water color appeared to be around 3 to 4 on the standard water color gauge. Considering only the Banda Sea, it seemed that the water color was generally more favorable in the eastern than in the western part. As for the vertical changes in water temperature, whereas in the Inner South Seas the difference between the surface and the 50-meter level is only 0.1° - 0.2° or almost negligible, in this area it is 1° - 3° . The temperatures at the 100-meter level had a minimum of 18.8° and a maximum of 21.5°, far lower than the 24-25° of the waters of our South Sea islands. After completing fishing tests at four places in the Banda Sea we made our last station at the eastern end of Seram I. In this area all there is to record of oceanographic conditions is that the current was northwesterly with a velocity of 0.8 knots. In other respects the situation was the same as in the Banda Sea, with nothing worthy of special note.

On July 21 we traversed Dampier Strait and set a course for Palau. I will conclude with some remarks on the currents and oceanographic conditions which were observed along the way.

On July 22 at the noon position of 1° 51'N, 132° 10'E the current flowed [illegible] at the low velocity of 0.36 knot. It is thought that this area may be the northern limit of the southern Equatorial Current. The water color improved notably from this area on, and while steaming we caught one small yellowfin (78 cm long) on a trolling line.

On July 23 at the noon position of 4° 17'N, 133° 28'E the current flowed [illegible] with a velocity of 1.58 knots, indicating that we were in the Equatorial Countercurrent. On the following day, the 24th, at the noon position of 5° 1'N, 134° 0'E the current was SSE with a velocity of 0.97 knots. From which we could see the northward movement of the Equatorial Countercurrent.

(3) Fishing situation

First Trial

Morning and evening are, of course, considered the most suitable times for conducting experimental fishing for tuna with longlines, however, because the vessel was scheduled to put in at Dilli in Timor, a trial was made on the preceding day, July 5, at 1530 about 8 miles off the west side of Wetar I. using 50 baskets of line set in a westerly direction.

From the time the vessel passed Ceram I. and entered the Banda Sea the color of the sea water had generally appeared unfavorable, but as we moved gradually south into the vicinity of Wetar I. it improved. Observations on the station showed a transparency of 40 meters, and flocks of birds were seen flying in the vicinity. Although good tuna fishing was anticipated, only 4 yellowfin, 1 black marlin, and 2 skipjack were taken and the catch rate was less than 2 fish per 100 hooks. None of the fish were shark-bitten. It was felt that the transparency of the water was too great.

Second Trial

After leaving Dilli we rounded the eastern tip of Timor and entered the Timor Sea. The second station was fished about 30 miles off shore. At 0505 July 9, 200 baskets were set in a SE direction. The bait, as in the previous trial, was a mixture of frozen saury and salted sardine which we had brought from Japan. Three hours and 40 minutes were required to set the 200 baskets of line. We began patrolling the line immediately after it was set, and we saw numerous schools of skipjack while doing so. These skipjack appeared to be small fish of about 1 kan /8.27 pounds/ weight. While patrolling the lines, we took in one marlin (black) of about 40 kan, one yellowfin, and one blue shark.

We began hauling in the lines at 1500. Because the weight of the fish on the lines was too great for the buoyancy of the floats, the gear sank and the lines broke four times while we were hauling them. As a result 11 hours were required to haul in the 200 baskets of gear, and the work was not finished until 0220 the following day, July 10. The catch was 18 yellowfin, 10 albacore, 3 big-eyed, 1 white marlin, 2 black marlin, and 16 sharks, and 13 fish (10 yellowfin, 3 marlin) were damaged by shark-bite. The catch rate at this location, if the shark-bitten fish are not counted, was 2.8, and with the shark-bitten fish it was 3.9. Furthermore, because of the difficulty of getting materials, the gear used in this test was made with rather fine line and wire in some of its branch lines, and for this reason 50 of the branch lines or hooks were broken off the gear by the fish. If these were added in to the total, the catch rate would be considerably increased.

Third Trial

The position of this fishing ground was 8° 53'S, 129° 55'E, south-

west of Tanimbar I. On July 11 at 0505 120 baskets of gear were set in an ESE direction. It required 5 hours and 10 minutes to set the lines, and the total length of the lines was 10.5 miles. While patrolling the lines we boated 5 yellowfin and 1 big-eyed. Eight hours were spent in hauling the lines, and the total catch was 14 yellowfin, 2 big-eyed, 1 albacore, and 1 broadbill; 47 fish were damaged by sharks and killer whales. Most of the yellowfin taken were large ones over 130 cm in length. The catch rate was 2.5 without the shark-bitten fish, or 9.0 including them.

In addition 31 hooks were broken off the lines so, if this is taken into consideration, the catch rate should be further increased in view of the amount of fish occurring in the area. A peculiar phenomena which should be noted in connection with this trial is the fact that, aside from the fish damaged by sharks, there were 40 fish eaten by killer whales. The remains of fish eaten by killers differ from those damaged by sharks. In the case of the killers only the head of a hooked tuna is left, and the distinction is clear at a glance.

Fourth Trial

The position of this fishing ground was 7° 05'S, 130° 30'E, to the west of Tanimbar I. On July 12 at noon 120 baskets were set in an ESE direction. About eight hours were required for setting the lines, and the catch was 80 yellowfin, 1 true marlin, 1 sailfish, 1 big-eyed, and 4 sharks, with 18 fish damaged by sharks. In addition 17 hooks were broken off the lines. The catch rate was 11.5 without the shark-bitten fish, or 14.0 with them. Measurements of the yellowfin taken showed that the greatest number fell within the range of 130 cm long (assumed to be fish in their ninth year). The big-eyed tuna was about 153 cm long. When the yellowfin were gutted, the gonads were examined, but all of them were found to be immature with no distinguishable ova.

Fifth Trial

The position of the fishing ground was 6° 58'S, 130° 58'E, off the west side of Tanimbar I. On July 13 at 0600 we set 185 baskets of line in a NW direction. The excessive weight of the fish on the lines sank the gear and it could not be hauled in with the line-hauler. The attempt was made to haul it by manpower, but in the end the lines parted and 50 baskets of gear was unavoidably lost. A long time was required to haul the lines in, the operation beginning at 1150 and being completed at 2350. It actually took 12 hours.

The catch was 52 yellowfin, 1 big-eyed, 1 black marlin, 1 true marlin, and 5 sharks, with 10 more fish shark-damaged and 10 hooks torn off the line. The catch rate was 6.8 without the shark-bitten fish, and 8.0 if they are included. Since it can be presumed that there were many tuna hooked on the 50 baskets which were lost, the catch rate should be considered even higher.

The incidence of sharks all over this area is very high.

Sixth Trial

The position of the fishing ground was 5° 13'S, 131° 15'E, off to the west of Kei I. On July 15 at 0540 100 baskets of gear were set in an ESE direction for a total length of 8.5 miles. Hauling in the lines was begun at 1225 and completed at 1850. During the hauling-in 7 baskets of line sank, but the line did not break and we were able to recover this gear. The catch was 78 yellowfin, 2 big-eyed, and 6 sharks, with 16 fish shark-bitten and nine branch lines broken off.

The catch rate was 13.3 not counting the shark-bitten fish, or 16.0 if these are included. Measuring the yellowfin showed that the smallest was just under 1 meter and most of them were 110 - 120 cm in length. An examination of the stomach contents made when gutting the fish showed that they had been eating mostly squid.

Seventh Trial

The position of this fishing ground was 5° 15'S, 131° 15'E, off Kei I. On July 16 at 0510 100 baskets were set in an ESE direction. In order to prevent the weight of the hooked fish from sinking the gear we began from this day on to attach two glass floats and two paulownia wood floats to each of the float lines. While patrolling the lines we boated 7 yellowfin.

The total catch was 47 yellowfin, 3 big-eyed, 1 white marlin, and in addition 8 shark-bitten fish and 4 broken branch lines. The catch rate was 8.7 if the shark-bitten fish are excepted, or 10.0 if they are included.

Eighth Trial

The position of the fishing ground was 4° 41'S, 130° 31'E, east of Banda I. On July 17 at 0400 130 baskets were set in a SExE direction. Although the water color was good on the fishing ground, it appeared somewhat turbid. While patrolling the line we hauled in 2 yellowfin and 3 big-eyed. The total catch was 41 yellowfin, 11 big-eyed, and 7 sharks, in addition to which there were 21 shark-bitten fish, and 13 broken lines. The catch rate was 7.4 without the shark-bitten fish, or 10.3 if these are included. The yellowfin in the catch were all large fish over 130 cm in length.

Ninth Trial

The position of this fishing ground was 4° 37'S, 130° 22'E, east of Banda I. On July 18 at 0400 130 baskets of gear were set in a [illegible] direction. On the fishing ground the water temperature at the 100-meter level was 19° and the water color was good, although appearing somewhat turbid, with a transparency of 25.5.

While patrolling the lines we hauled in 12 yellowfin and 1

shark-bitten yellowfin. The total catch was 116 yellowfin, 6 big-eyed, and 17 sharks, in addition to which there were 38 shark-damaged fish and 17 broken lines. Eight hours were required for hauling in the lines, and the catch rate was 18.6 without the shark-bitten fish, or 20.5 if these are included. This was the highest rate obtained in these tests. There was also a particularly large amount of shark damage at this position, being in this respect second only to the ground fished in Trial 3.

Tenth Trial

The position of this fishing ground was 3° 35'S, 131° 54'E, east of Ceram I. After six trials in the Banda Sea the expedition had completed its fishing operations and was heading back to its base, but the lines were set just as an experiment and nothing much was expected from the grounds. On July 19 at 1645 20 baskets were set in a SExS direction.

The water color on the fishing ground was bad, with a transparency of 11 meters. The catch was 4 yellowfin, 2 sharks, and 2 shark-bitten fish. The catch rate was 3.3 excluding the damaged fish, or 5.0 if these are included.

4. Conclusion

This investigation was carried out in three sea areas, the Timor Sea, the Arafura Sea, and the Banda Sea, however, the number of fishing trials made in the Timor and Arafura seas was small and it is feared that the data are insufficient for evaluating those fishing grounds. The single station fished in the former showed a catch rate of 3.9 while the latter had a rate of 9.0, showing that in general it can be considered to have a certain value as a fishing ground.

In the results of six trials in the Banda Sea the catch rates ranged from a minimum of 8.0 to a maximum of 20.5, these high rates indicating that tunas occur there in considerable abundance. Among the tunas yellowfin were most numerous followed by big-eyed, and marlin were plentiful. Albacore occurred in the least abundance, just as in the waters of our South Sea Islands. The yellowfin were generally large fish, many of them being over 130 cm long. An examination of the gonads of the yellowfin revealed that during the period covered by these investigations they are almost completely unripened.

From a consideration of the relationship between oceanographic conditions and the fishing situation it appears that the water temperatures at the 100-meter level are far lower than in the Islands and that 18° to 20° are suitable temperatures.

Sharks occur in remarkable abundance in the eastern part of the Banda Sea, and the investigations revealed that shark damage to hooked fish is great. The rate of such damage ran from 13% to 72% with an average of 47%. This high rate of shark damage is ample evidence of the undeveloped character of these grounds, and it is expected that such

damage will decrease in the future as tuna boats penetrate into and develop these grounds.

During the course of these investigations the author has felt deeply that, when the time comes that we can freely establish fishing bases in areas under foreign control, the tuna resources of these foreign waters have a boundless future.

The Banda Sea is within four or five days' sailing for vessels based at Palao, and for vessels coming from Japan Proper the trip one way would require ten days. This is less than half the time required for vessels fishing in the waters of our South Sea Islands. It is hoped that commercial operators will increasingly make this area their objective for fishing and development.

Relationship Between Catch Rate, Water Temperature, and Transparency

Number	Station	Catch Rate*	Temperature at 100m	Transparency
			°C	Meters
1	9	20.5	19.0	25.5
2	6	16.0	20.1	22.0
3	4	14.0	20.0	26.0
4	8	10.3	18.8	26.0
5	7	10.0	19.9	24.0
6	3	9.0	19.8	27.0
7	5	8.0	21.5	37.0
8	10	5.0	20.4	11.0
9	2	3.9	23.4	27.0
10	1	2.0	23.4	27.0

* fish per 100 hooks

From the above data it appears that temperatures of 18-20° at the 100-meter level are favorable for fishing, and in general a tendency can be seen for the fishing to become poorer when the temperature rises above 23°. Optimum transparencies appear to be between 23 and 27 meters, while clear water with transparencies greater than 30 meters and turbid (unclear) water with transparencies less than 10 meters are unfavorable for fishing.

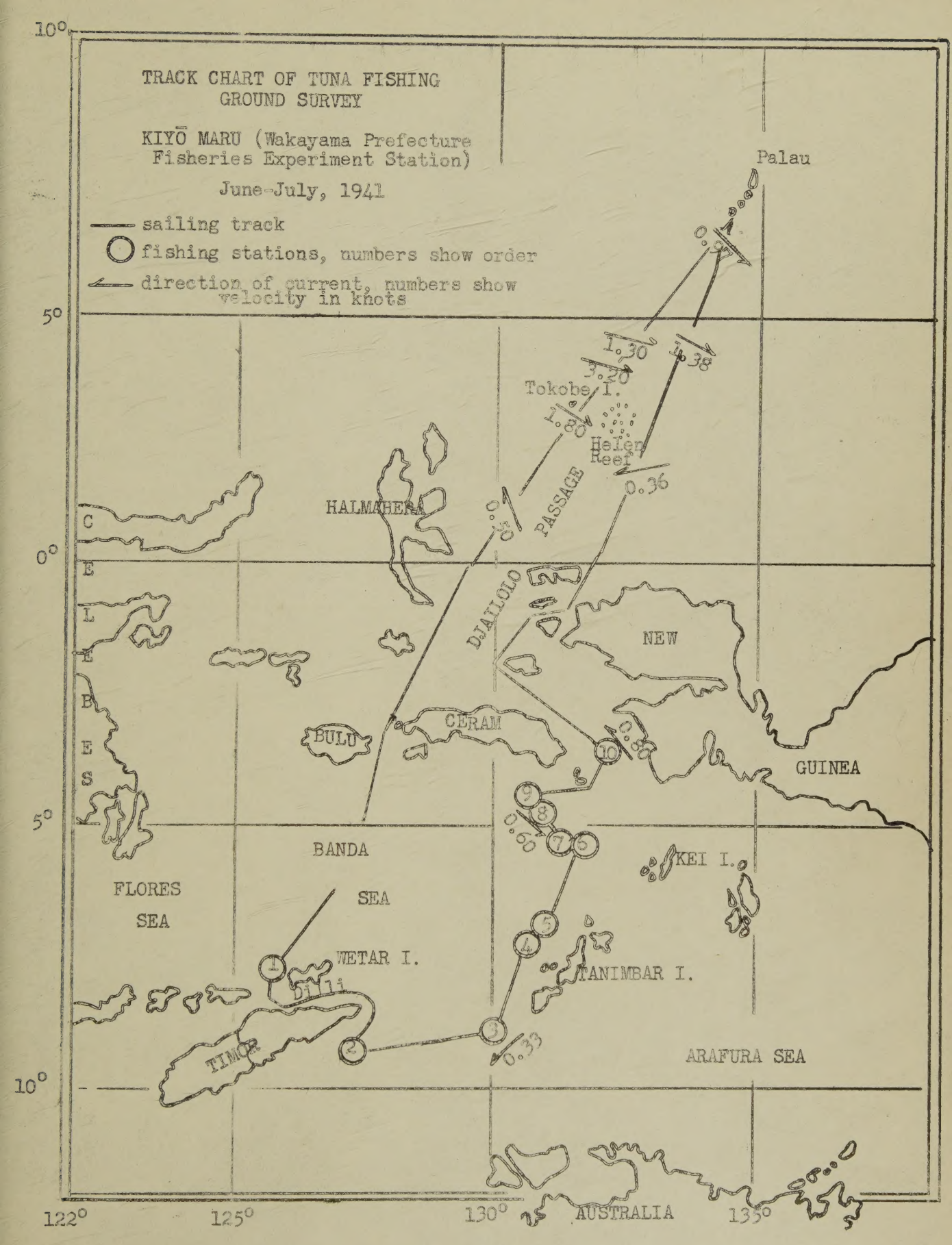
Table of Fishing Trials

Trial No.	Date	Amount of Gear	Setting Gear		Hauling Gear		Catch	Catch Rate	
			Began	Finished	Began	Finished		*	**
1	7-5	50(bskts.)	1530	1630	2005	2237	4 yf, 1 bm, 1 bb, 2 sk	2.0	2.0
2	7-9	200	0505	0845	1505	0225	18 yf, 10 alb., 3 b-e, 2 bm, 1 wm, 13 s-b	3.9	2.8
3	7-11	120	0505	0716	1328	2015	14 yf, 2 b-e, 1 alb.	9.0	2.5
4	7-12	120	0007	1410	1725	0106	1 bb, 47 sb, 80 yf. 1 tm, 1 sf, 1 b-a, 18 sb [sic]	14.0	11.5
5	7-13	185	0645	1010	1150	2350	52 yf, 1 b-e, 1 bm, 1 tm, 10 sb	8.0	6.8
6	7-15	100	0540	0738	1225	1850	78 yf, 2 b-e, 16 sb	16.0	13.3
7	7-16	100	0510	0715	1135	1720	47 yf, 43 b-e, 2 wm, 21 sb	10.0	10.0
8	7-17	120	0515	0750	1125	1835	42 yf, 11 b-e, 21 sb	10.3	7.4
9	7-18	130	0520	0808	1225	2020	116 yf, 6 b-e, 38 sb	20.5	15.6
10	7-19	20	1645	1712	1840	1945	4 yf, 2 sb	5.0	3.3

* Catch rate including shark-bitten fish. ** Catch rate excluding shark-bitten fish.

yf ... yellowfin b-e ... big-eyed bm ... black marlin tm ... true marlin wm ... white marlin
sf ... sailfish bb ... broadbill alb .. albacore sb ... shark-bitten sk ... skipjack

(Note) The amount of gear for No. 5 is 185 baskets, but 50 of these baskets were lost so the amount of gear hauled in was 135 baskets. The catch rate is calculated for 135 baskets.


TRACK CHART OF TUNA FISHING GROUND SURVEY
KIYŌ MARU (Wakayama Prefecture Fisheries Experiment Station)
June-July, 1941
sailing track
fishing stations, numbers show order
direction of current, numbers show velocity in knots
Palau
0.9
1.30
1.38
3.20
Tokobe I.
1.80
Helen Reef
0.36
HALMAHERA
PASSAGE
0.0
DJAILOLO
NEW
GUINEA
CERAM
BULU
0.88
10
9
8
7
6
0.50
BANDA
SEA
KEI I.
FLORES
SEA
WETAR I.
5
4
3
TANIMBAR I.
2
1
TIMOR
0.33
ARAFURA SEA
AUSTRALIA
10°
5°
0°
50
C
E
L
E
B
E
S
122°
125°
130°
135°